III. Rejection of claims 1-82 under 35 USC 102(a)

In the claims:

Please amend the claims as shown (a complete claims listing is appended hereto):

1. (Currently amended) A high sensitivity atomic magnetometer comprising
   a) a sensing cell containing a mixture comprising an alkali metal vapor and a buffer gas, wherein the sensing cell is exposed to a background magnetic field lower than a first predetermined value;
   b) means for increasing the magnetic polarization of the alkali metal vapor thereby increasing the sensitivity of the alkali metal vapor to a low intensity magnetic field;
   c) magnetizing means for imposing a magnetic field on a volume of space comprising the sensing cell;
   d) means for probing the magnetic polarization of the alkali metal vapor, the probing means providing an output from the alkali metal vapor, the output comprising characteristics related to the low intensity magnetic field; and
   e) measuring means wherein the measuring means receives the output, determines the characteristics of the low intensity magnetic field, and provides a representation of the low intensity magnetic field, wherein the measuring means comprises a plurality of output detecting means;

   ~~wherein the limit of detectability of the atomic magnetometer is lower than a second predetermined value~~.

4. (Currently amended) The atomic magnetometer described in claim 1 wherein the ~~second predetermined value is about 1~~ limit of detectability of the atomic magnetometer is less than 10 femtotesla $(Hz)^{-1/2}$.

29. (Currently amended) The atomic magnetometer described in claim 1 wherein the ~~measuring means comprises one or more~~ plurality of output detecting means ~~that provides one or more~~ provides a plurality of signals comprising characteristics related to

the low intensity magnetic field, and ~~one or more~~ wherein the measuring means further comprises a plurality of signal processing means for receiving the ~~one or more~~ plurality of signals and providing the representation.

30. (Currently amended) The atomic magnetometer described in claim ~~29~~ 21 wherein ~~the~~ an output detecting means comprises radiation detecting means that detects a second beam of radiation output from the alkali metal vapor.

34. (Currently amended) The atomic magnetometer described in claim 30 wherein the radiation detecting means comprises ~~one or more~~ a plurality of photodetectors, wherein each photodetector provides a signal comprising characteristics related to the low intensity magnetic field.

38. (Currently amended) The atomic magnetometer described in claim 29 wherein ~~the measuring means comprises a plurality of output detecting means, wherein~~ a first output detecting means detects radiation traversing a first region of the alkali metal vapor and a second output detecting means detects radiation traversing a second region of the alkali metal vapor, wherein the first and second regions are different.

39. (Currently amended) The atomic magnetometer described in claim 38 wherein the first output detecting means provides a first signal to a first signal processing means and the second output detecting means provides a second signal to a second signal processing means, and the first signal processing means provides a representation of the low intensity magnetic field sensed in the first region and the second signal processing means provides a representation of the low intensity magnetic field sensed in the second region.

42. (Currently amended) A high sensitivity atomic magnetometer that generates a representation of a first magnetic field originating within a sample volume, the magnetometer comprising

a) a sensing cell sensitive to low intensity magnetic fields comprising an alkali metal vapor and a buffer gas, the sensing cell being adjacent to ~~a~~ sample volume

including a component generating a first magnetic field, wherein the sensing cell is exposed to

i) the first magnetic field; and

ii) a background magnetic field lower than a first predetermined value;

b) means for increasing the magnetic polarization of the alkali metal vapor, wherein the magnetic polarization of the alkali metal vapor includes a contribution from the first magnetic field;

c) magnetizing means for imposing a second magnetic field on a volume of space comprising the sensing cell;

d) means for probing the magnetic polarization of the alkali metal vapor, the probing means providing an output from the vapor comprising characteristics related to the first magnetic field; and

e) measuring means for receiving the output, determining the characteristics of the first magnetic field, and providing a representation of the first magnetic field, wherein the measuring means comprises a plurality of output detecting means; ~~wherein the limit of detectability of the atomic magnetometer is lower than a second predetermined value~~.

46. (Currently amended) The atomic magnetometer described in claim 42 wherein the ~~second predetermined value is about 1~~ limit of detectability of the atomic magnetometer is less than 10 femtotesla $(Hz)^{-1/2}$.

54. (Currently amended) The atomic magnetometer described in claim 42 wherein the ~~measuring means comprises one or more~~ plurality of output detecting means ~~that provides one or more~~ provides a plurality of signals comprising characteristics related to the low intensity magnetic field, and ~~one or more~~ wherein the measuring means further comprises a plurality of signal processing means for receiving the ~~one or more~~ plurality of signals and providing the representation.

56. (Currently amended) The method described in claim 55 wherein the ~~second predetermined value is about 1~~ limit of detectability of the atomic magnetometer is less than 10 femtotesla $(Hz)^{-1/2}$.

62. (Currently amended) The ~~atomic magnetometer~~ method described in claim 55 wherein the sensing cell transmits a plurality of beams of radiation through the alkali metal vapor, wherein at least two of the beams are physically resolved from each other.

65. (Currently amended) The ~~atomic magnetometer~~ method described in claim 55 wherein the magnetizing means provides a probing magnetic field in one, two, or all three of the orthogonal directions, x, y , and/or z.

66. (Currently amended) The method described in claim 55 wherein the ~~measuring means comprises one or more~~ plurality of output detecting means ~~that provides one or more~~ provides a plurality of signals comprising characteristics related to the low intensity magnetic field, and ~~one or more~~ wherein the measuring means further comprises a plurality of signal processing means for receiving the ~~one or more~~ plurality of signals and providing the representation.

67. (Currently amended) A method for providing a representation of a first magnetic field originating within a sample volume, the method comprising the steps of:

a) providing a high sensitivity apparatus described in claim 42;

b) identifying a sample volume adjacent to the sensing cell;

c) increasing the magnetic polarization of the alkali metal vapor, wherein the magnetic polarization of the alkali metal vapor includes a contribution from the first magnetic field;

d) reorienting the magnetic polarization of the alkali metal vapor using a the second magnetic field;

e) probing the magnetic polarization of the reoriented alkali metal vapor with the probing means, wherein the probing means provides an output whose characteristics are related to the first magnetic field; and

f) receiving the output in the measuring means, wherein the measuring means determines the characteristics of the first magnetic field and provides a representation of the first magnetic field detected by the sensing cell.

69. (Currently amended) The method described in claim 67 wherein the ~~second predetermined value is about 1~~ limit of detectability of the atomic magnetometer is less than 10 femtotesla $(Hz)^{-1/2}$.

79. (Currently amended) The method described in claim 67 wherein the ~~measuring means comprises one or more~~ plurality of output detecting means ~~that provides one or more~~ provides a plurality of signals comprising characteristics related to the low intensity magnetic field, and ~~one or more~~ wherein the measuring means further comprises a plurality of signal processing means for receiving the ~~one or more~~ plurality of signals and providing the representation.

Please add new claims 83-94:

83. (New) The atomic magnetometer described in claim 39 wherein the measuring means further comprises computational means for differentially comparing a first signal and a second signal in a way that is effective to minimize a contribution of the background magnetic field in the first signal and the second signal.

84. (New) The atomic magnetometer described in claim 54 wherein a first output detecting means detects radiation traversing a first region of the alkali metal vapor and a second output detecting means detects radiation traversing a second region of the alkali metal vapor, wherein the first and second regions are different.

85. (New) The atomic magnetometer described in claim 83 wherein the first output detecting means provides a first signal to a first signal processing means and the second output detecting means provides a second signal to a second signal processing means, and the first signal processing means provides a representation of the low intensity magnetic field

sensed in the first region and the second signal processing means provides a representation of the low intensity magnetic field sensed in the second region.

86. (New) The atomic magnetometer described in claim 54 wherein the measuring means further comprises computational means for differentially comparing a first signal and a second signal in a way that is effective to minimize a contribution of the background magnetic field in the first signal and the second signal.

87. (New) The method described in claim 55 wherein the radiation detecting means comprises a plurality of photodetectors, wherein each photodetector provides a signal comprising characteristics related to the low intensity magnetic field.

88. (New) The method described in claim 66 wherein a first output detecting means detects radiation traversing a first region of the alkali metal vapor and a second output detecting means detects radiation traversing a second region of the alkali metal vapor, wherein the first and second regions are different.

89. (New) The method described in claim 66 wherein the measuring means further comprises computational means for differentially comparing a first signal and a second signal in a way that is effective to minimize a contribution of the background magnetic field in the first signal and the second signal.

90. (New) The method described in claim 67 wherein the radiation detecting means comprises a plurality of photodetectors, wherein each photodetector provides a signal comprising characteristics related to the low intensity magnetic field.

91. (New) The method described in claim 79 wherein a first output detecting means detects radiation traversing a first region of the alkali metal vapor and a second output detecting means detects radiation traversing a second region of the alkali metal vapor, wherein the first and second regions are different.

92. (New) The method described in claim 79 wherein the measuring means further comprises computational means for differentially comparing a first signal and a second signal in a way that is effective to minimize a contribution of the background magnetic field in the first signal and the second signal.

93. (New) A high sensitivity diagnostic imaging atomic magnetometer comprising

a) a sensing cell sensitive to low intensity magnetic fields, the sensing cell comprising an alkali metal vapor and a buffer gas, the sensing cell being adjacent to a sample volume for containing at least a portion of a subject that generates a first magnetic field, wherein the sensing cell is exposed to

i) the first magnetic field; and

ii) a background magnetic field;

b) a first radiation generating means that generates a first beam of radiation illuminating the alkali metal vapor, the first beam being effective to increase the magnetic polarization of the alkali metal vapor, wherein the magnetic polarization of the alkali metal vapor includes a contribution from the first magnetic field;

c) magnetizing means for imposing a second magnetic field on a volume of space comprising the sensing cell;

e) one or more second radiation generating means that generates one or more second beams of radiation traversing the alkali metal vapor for probing the magnetic polarization of the alkali metal vapor, the one or more second radiation beams providing one or more second output beams of radiation after they traverse the vapor, the second output beams comprising characteristics related to the first magnetic field;

f) a plurality of output detecting means that detect the second output beams and provide a plurality of signals comprising characteristics related to the first magnetic field;

g) a computational module comprising a plurality of signal processing means for

i) receiving the plurality of signals;

ii) differentially comparing a first signal and a second signal in a way that is effective to minimize a background magnetic field component in the signals thereby providing resultant output signals;

iii) determining the characteristics of the first magnetic field present in the resultant output signals;

iv) and providing a representation of the first magnetic field;

wherein the representation is useful in diagnostic imaging of the subject.

94. (New) A method of conducting diagnostic imaging on a subject comprising the steps of

a) placing at least a portion of the subject that generates a first magnetic field in a sample volume adjacent to a sensing cell sensitive to low intensity magnetic fields, the sensing cell comprising an alkali metal vapor and a buffer gas, wherein the sensing cell is exposed to

i) the first magnetic field; and

ii) a background magnetic field;

b) increasing the magnetic polarization of the alkali metal vapor by illuminating the alkali metal vapor with a first beam of radiation, wherein the magnetic polarization of the alkali metal vapor includes a contribution from the first magnetic field;

c) reorienting the magnetic polarization of the alkali metal vapor by imposing a second magnetic field on a volume of space comprising the sensing cell;

e) probing the magnetic polarization of the alkali metal vapor with one or more second beams of radiation that traverse the alkali metal vapor, the one or more second radiation beams providing one or more second output beams of radiation after they traverse the vapor, the second output beams comprising characteristics related to the first magnetic field;

f) detecting the second output beams with a plurality of output detecting means that provide a plurality of signals comprising characteristics related to the first magnetic field;

g) receiving the plurality of signals in a computational module comprising a plurality of signal processing means that